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Nanotextured surfaces with enhanced optical and thermodynamic properties fabricated by a maskless reactive ion etching method

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We discuss a simple method for one-step maskless fabrication of nanotextured surfaces in Si and replication of such surfaces in polymer. The nanotextures are fabricated on silicon wafers by using a simple one-step method of reactive ion etching at different processing time and gas flow rates of. Reactive ion etching (RIE) is a dry etching technique that can be used to structure silicon surfaces without masks through the combined effect of a corrosive gas (SF_6 and/or CH_4) and a passivating gas (O_2) [1]. Depending on specific process parameters, the nanotexture can be tuned to have different optical surface properties ranging from spiky nanograss yielding antireflective mat-black surfaces (black Si) to inverted nanopyramids yielding distinct milky white surfaces [2]. Moreover, by subsequently coating the surfaces with hydrophobic 1H,1H,2H,2H-perflourodecyltrichlorosilane (FDTS) [3] or applying an oxygen plasma treatment, the wetting properties of the surfaces can become superhydrophobic or superhydrophillic respectively. Strong anti-wetting behaviour can also be obtained by replicating the nanograss in hydrophobic polymer such as polypropylene (PP). To showcase the feasibility of the polymer replication, we demonstrated large area roll-to-roll (R2R) replication of nanograss by employing an industrial extrusion coating process [4] to fabricate superhydrophobic PP polymer foils with water contact angles approaching 160° and droplet roll-off angles below 10° [5].

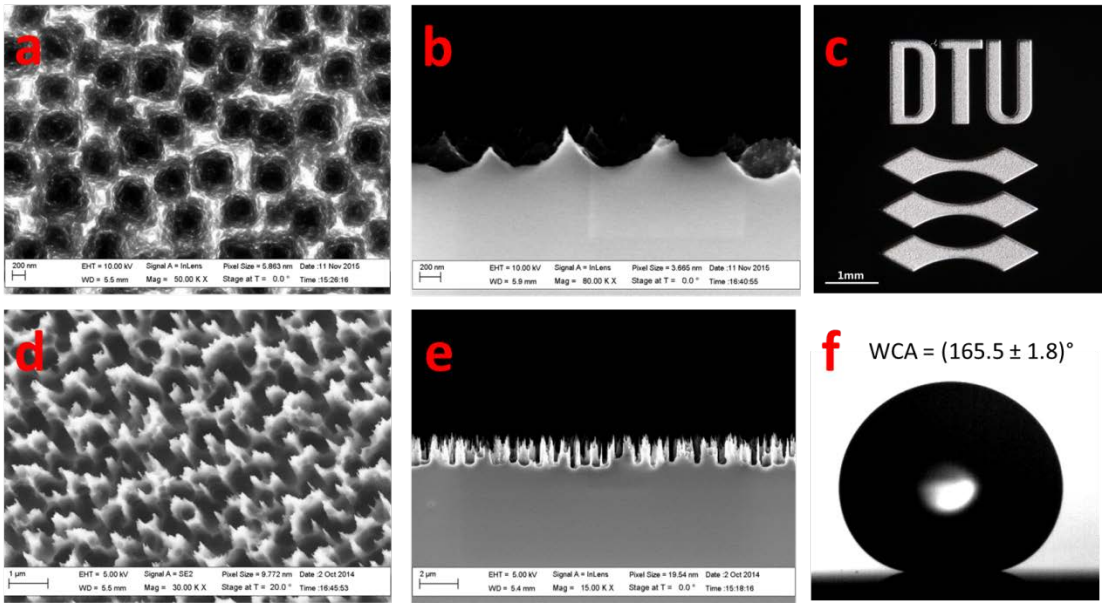

Figure 1. a) Top view Scanning electron micrograph (SEM) of inverted pyramid “white Si” structure. b) Same structure as a) in cross-section view SEM. c) DTU logo fabricated with “white” and “black” Si nanotexture. d) 20° tilted view SEM of nanograss texture. f) Same structure as d) in cross-section view SEM. Micro-droplet resting on FDTS coated nanograss textured Si surface.

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